Energy innovators: University College of the Fraser Valley Looks into new energy management initiatives

OEE

Energy Efficiency
Case Study

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ENERGY EFFICIENCY

ENERGY INNOVATORS

UNIVERSITY COLLEGE OF THE FRASER VALLEY LOOKS INTO NEW ENERGY MANAGEMENT INITIATIVES

INTRODUCTION

The University College of the Fraser Valley (UCFV), located 100 km east of Vancouver, adopted an energy management plan almost a decade ago. As early as 1991, UCFV began encouraging and promoting energy efficiency on its campuses. These past initiatives have earned UCFV the reputation of having one of the lowest unit energy costs among Canadian colleges that have provided energy consumption information to Natural Resources Canada's (NRCan's) Office of Energy Efficiency (OEE).

COLLEGE BACKGROUND

After nine years of holding classes in church basements, former schools and retail locations, UCFV opened its present campuses in Chilliwack and Abbotsford in 1976 and 1983 respectively. In addition to these two campuses, there is a smaller campus in Mission, shared with a high school and a civic theatre, which makes up the Heritage Park Centre. UCFV also has a satellite campus in Hope and an information centre in Agassiz. UCFV's 17 buildings have a total floor area of 46 200 m^2 (497 293 ft^2). The buildings are occupied throughout the year by 6500 registered credit students and some 17 000 non-credit students. UCFV employs about 592 full-time and 400 part-time faculty and staff, and it has an approximate total operating budget of $41.8 million.

Natural Resources Canada
Office of Energy Efficiency

Ressources naturelles Canada
Office de l'efficacité énergétique

Canada

RETROFIT INITIATION

In an attempt to explore opportunities to further reduce its energy consumption, UCFV expressed an interest in NRCan's plan to complete an energy audit of a Canadian college. By conducting this audit, which was completed by Prism Engineering, NRCan was able to pursue its goals and provide benefits to UCFV. Some of NRCan's key objectives for the energy audit, which also proved beneficial to UCFV and would be of use to other colleges as well, are outlined below.

- Objective 1: Determine the lessons learned through past energy management experiences, which can be useful for future projects and in verifying whether it is feasible to expect 20 percent savings in energy consumption and costs.
- Objective 2: Determine the impact of the Energy Innovators Initiative.
- Objective 3: Provide audit recommendations and potential projects for UCFV.
- Objective 4: Show that, even if the college adopted an energy management plan some time ago, there is still opportunity for additional energy efficiency measures.

The findings of the audit are documented in the following sections.

OBJECTIVE 1: LESSONS LEARNED

Past Initiatives

All of the UCFV buildings built in the past 10 years have been constructed with energy management in mind. For example, the majority of the buildings use light-emitting diode (LED) exit signs and fluorescent rather than incandescent lighting. UCFV installed many fixtures using T-8 lamps, which are more energy efficient than the traditional T-12 light fixtures, even though they were not standard at the time. Some of the buildings also use water-source heat pumps and variable-volume air-handling units with adjustable speed drives to control energy consumed for ventilating, heating and cooling. In 1996 UCFV also initiated an in-house awareness program to educate staff, students and faculty. Through these initiatives, UCFV was able to reduce its energy consumption by 20 percent between 1991 and 1996, which meant approximately $200,000 in annual energy savings. By 1996, UCFV had reduced its total annual energy consumption to 14 612 460 ekWh, at a cost of $422,155. It was concluded from this finding that it is reasonable to achieve 20 percent savings through energy management projects. The following table summarizes the savings realized from these past initiatives.

Project	Capital Investment	Power-Smart Rebate	Cost Savings	Consumption Savings (ekWh)
New Energy-Efficient Buildings	$0	$155,610	$49,950	999 000
Lighting Upgrades	$163,000	$65,300	$20,578	614 500
System Upgrades	$89,000	$45,375	$59,203	184 075
Reduction in Operating Hours	$0	$0	$75,000	0

Obstacles

Achieving such a high level of savings was not an easy task. UCFV faced many obstacles in becoming energy efficient. The implementation of certain initiatives caused problems, but these were resolved through experience. The obstacles and their solutions are presented in the following table.

OBSTACLE	*CAUSE*	*CONSEQUENCE*	*SOLUTION*	*BENEFITS*
Improper documentation of projects and programs	Tracking done internally because staff were reluctant to hire outside consultant.	Changes in surface area not recorded, so estimated area presented to NRCan was 25 percent less than actually audited.	Hire an outside consultant.	Consultant could oversee all projects to ensure that they are all being recorded properly and consistently.
No means of metering or tracking	UCFV has over 20 utility accounts for three campuses.	Cannot obtain complete data to ensure that energy efficiency is taking place, costing UCFV money.	Consolidate metering and billing. Amalgamate utility accounts.	By consolidating gas metering and billing, a saving of $19,500 could be realized.
No adequate sub-metering	Metering covers broad areas.	College does not know where energy is being used.	Assign direct costs for energy use to departments.	UCFV will know which departments are large energy consumers and can implement specific energy management programs.
Apathy toward energy efficiency among building occupants	Energy efficiency is not a priority for senior management. Students are not involved in projects. Energy efficiency success stories are not acknowledged internally.	Energy efficiency cannot be maximized.	Make occupants aware of environmental and monetary costs of their actions. Create an environment club. Spread success stories throughout UCFV to recognize people's efforts.	Senior management will recognize costs associated with energy consumption. Students will get involved. Energy management programs will be promoted and encouraged.

Lessons Learned

UCFV used these obstacles as an opportunity to learn many lessons that will be beneficial in future energy management endeavours. UCFV learned, for example, that energy management is exceptionally difficult to implement and maintain without developing an Energy Management Action Plan. The institution learned from its previously improper documentation that an "energy champion" is necessary to maintain an energy management plan in the long term. It also discovered that sufficient time must be allocated for proper tracking of energy management to occur. It took UCFV several years to put together its Energy Management Plan, but it now knows exactly where to implement projects for the most beneficial savings, who is in charge and how much time must be budgeted for each project.

- Lighting: UCFV has learned to be aware of potential problems in future lighting, control and mechanical projects. To avoid turning lights off, motion sensors must be strategically placed and have a significant time delay. High-pressure sodium lighting fixtures should be well ventilated to prevent ballasts from burning.
- Operating hours: By reducing building operating hours, an initiative introduced prior to 1996, the amount of time allowed for cleaning classrooms after night classes becomes severely limited. It is also important to remember that each control system has its advantages and disadvantages, and that none of them are maintenance-free.
- Mechanical: UCFV learned that it is worthwhile to use input reactors when installing variable speed drives. Non-CFC equipment must be considered when replacing refrigerants.
- Tracking: UCFV has also discovered that there are several issues to be considered before the construction of a new building. The institution learned that software programs are an effective tool for tracking new surface areas. It also learned that metering should be installed with each new building. The construction of a new building also represents a perfect opportunity to review the overall power and gas supply.

OBJECTIVE 2: IMPACT OF THE ENERGY INNOVATORS INITIATIVE

Before Joining the Energy Innovators Initiative

Prior to 1996, UCFV was achieving energy savings of 20 percent, which meant $200,000 was saved yearly on energy bills. Despite realizing significant energy and cost savings through its many energy management initiatives until then, there had been a noticeable increase in UCFV's greenhouse gas emissions.

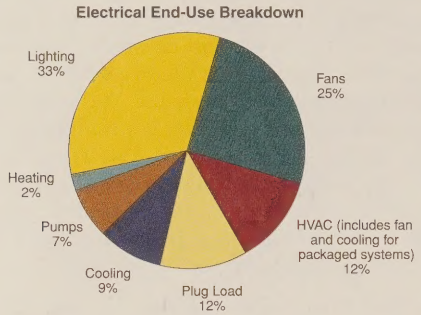
Impact of Joining the Energy Innovators Initiative

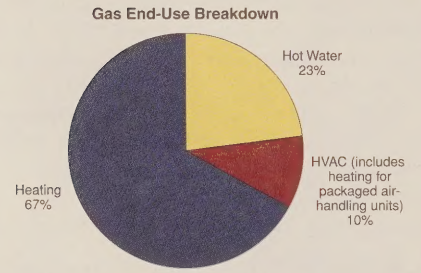
UCFV joined NRCan's Energy Innovators Initiative in 1996. Since then, UCFV's total greenhouse gas emissions have increased by 8.5 percent. This figure, however, does not take into consideration the construction of several new buildings, the dramatic increase in computer usage, weather changes, and a notable increase in building occupancy. Considering these variables, the production of greenhouse gas emissions remained relatively constant. When the expanded surface area is considered, the intensity decreased from $\$11/m^2$ to $\$10.5/m^2$, which is a reduction of 4.5 percent in energy costs since 1996. However, the energy cost per full-time equivalent (FTE) student increased from $92.80/FTE in 1996 to $99.95/FTE in 1998, an increment of 7.7 percent. This is most likely due to the growth in computer use. Although total carbon dioxide (CO_2) emissions increased by 5.4 percent, the CO_2 intensity (tonnes/m^2) decreased by 6.8 percent, from 0.044 tonnes/m^2 in 1996 to 0.041 tonnes/m^2 in 1998.

OBJECTIVE 3: AUDIT RECOMMENDATIONS

The UCFV energy audit was conducted in 1999 to determine how energy is consumed at the college and to determine whether it was possible for the institution to become even more energy efficient.

In 1998 UCFV consumed 16 201 511 ekWh of energy at a cost of $467,000. The estimated electricity and gas use are broken down as follows:





Estimated Savings

The audit found that despite past energy management efforts that had resulted in a 20 percent reduction, there was still potential to improve energy efficiency in terms of lighting, controls, mechanical systems and awareness. It is estimated that if further action is taken to reduce energy consumption in these areas, UCFV's CO_2 emissions could be reduced by 195.6 tonnes, or 10.6 percent a year. In addition, the audit showed that the energy cost could be reduced by a further 17 percent, which would lead to a saving of $80,000 each year with an investment of only $504,000 and a simple payback period of six years. The following recommendations were made in the categories of lighting, controls, mechanical systems, and communication and education.

Proposed Lighting Changes

During the walk-through audit, it was discovered that several buildings were using high-intensity discharge (HID) lighting fixtures, which are commonly used where more light is needed for industrial purposes. It was recommended that such light fixtures, along with the T-12 lamps still being used in some buildings, be replaced with energy-efficient T-8 lamps with electronic ballasts. If four T-12 lamps were replaced by two T-8 lamps, as recommended in the audit for a building on the Abbotsford campus, the result would be a saving in electrical consumption of 37 836 kWh a year. This would, in turn, decrease peak demand for that building by 8 kW. The estimated cost saving of this project is $1,936 a year, with a payback of slightly over four years, through a $8,288 installation investment. With T-8 lamps, the building occupants would benefit from the building's improved interior appearance and increased energy efficiency.

It was also recommended that three of the buildings on the Chilliwack campus convert their exit signs to use LED rather than incandescent light bulbs. LED exit signs require minimal maintenance, would cost only $1,100 to install, and would reduce energy consumption by 5397 kWh and save $270 per year if installed in all three buildings.

Controls

The audit found many ways to improve the energy efficiency of controls. Most of these recommendations involve reprogramming UCFV's direct digital controls (DDC). The DDC can be used to monitor demand at two meters and shed loads during peak periods to save 2 percent of demand, or 16 kW. This will save $1,184 per year.

The DDC can also be programmed to reduce energy consumption on statutory holidays. Over a year, these savings could add up to a reduction in electrical consumption of 44 259 kWh and a saving of $1,328, with a payback of just over a year. Furthermore, the audit indicated that DDC could be used to reduce the number of buildings operating on Saturdays and to completely shut down the Chilliwack campus on Sundays. Shutting down on Sundays, when the campus is seldom used, could save 79 472 kWh of electricity per year with a cost saving of over $2,000 annually and a payback period of under a year.

One of the major findings of the audit was that installing occupancy sensors, photocells and DDC to reduce lighting operation hours by turning off lights when they are not needed would significantly affect UCFV's energy bill. Installing occupancy sensors in the dental lab and lecture halls, for example, could result in a 14 838 kWh reduction in electrical consumption and $1,030 in cost savings. The investment on such a project would be only $4,375 with a 4.2-year payback period.

The installation of photocell lighting control in the cafeteria would save only $40 per year. Because this value is so low, the payback period would be almost eight years, even though the investment cost would only be $313.

Upgrading Mechanical Systems

Mechanical systems at UCFV were already quite efficient, so fewer upgrades were necessary. The report recommended that boiler efficiency upgrades be carried out in several buildings.

It was concluded which electronic pilot-less ignition on an atmospheric burner which eliminates the need for a permanent pilot flame and that by using an automatic vent damper, heat loss through the vent stack during standby periods could be reduced. By applying these measures, the seasonal efficiency of the boilers could increase to 79 percent from 72 percent. At the Abbotsford campus alone, the savings in gas consumption would be 740 GJ. This would save $2,490 per year, with an installation cost of $18,000.

Rooftop air-handling units should be replaced by higher efficiency units to save 17 187 kWh in electrical consumption and 135 GJ in gas consumption annually. An installation cost of $8,750 would result in a $1,558 reduction in energy costs per year. UCFV would benefit from upgrading its 48 rooftop units because the higher efficiency units provide much higher heating and cooling seasonal efficiency than standard units. A standard unit would be 76 percent efficient during the heating season and 9.3 percent efficient during the cooling season. The higher efficiency unit is 82 percent efficient during the heating season and 13 percent during the cooling season. Other advantages include:

- smoother and quieter compressor operation due to scroll-type design, rather than reciprocating;
- longer compressor life of scroll compressors; and
- improved heat exchanger construction, so the system lasts longer.

The report also recommended replacing outlet dampers on the faculty variable air volume (10 hp) unit with a variable speed drive control for a 30 percent saving, as well as converting the dishwasher electrical booster (30 kW) on the Abbotsford campus to gas. This would save 21 000 kWh in electrical consumption and reduce peak demand by 23 kW. The savings would be $1,931 a year with a 5.2-year payback period and a $10,000 investment cost. The final mechanical upgrade would be the installation of speed controls at both campuses to save $5,952 per year in the form of a 67 527 kWh reduction in electrical consumption and a 98 GJ reduction in gas consumption.

Increasing Energy Management Education

The audit also identified education as a key factor in an improved energy management plan. One of the main objectives of an awareness program is to encourage students and staff to get more involved in energy management initiatives. One initiative was to get users to turn off computers when they are not in use. The increase in computer use over the past few years has contributed to increased greenhouse gas emissions at UCFV since it joined the Energy Innovators Initiative in 1996. By simply promoting wiser computer use, UCFV could realize an annual saving of up to 52 299 kWh and $1,569, with an investment of only $2,500 for both campuses.

An in-house program has also been conducted to educate staff, students and faculty in energy conservation. Information obtained from BC Hydro and NRCan is distributed to building occupants once a year. Because these materials are free of charge, UCFV's program cost is minimal. UCFV staff obtain some of their energy management training from NRCan's Office of Energy Efficiency. OEE publications are used to gain ideas about new energy management innovations, and staff who attended the OEE *"Dollars to $ense" Energy Master Plan* workshop found it worthwhile.

A summary of the energy savings by category, as identified in the audit, is presented in the table below.

OBJECTIVE 4: ROOM FOR IMPROVEMENT

If the recommendations from the audit are implemented, a reduction in greenhouse gas emissions can still be realized in addition to the savings already gained prior to 1996. The expected savings are discussed in the box on the next page.

These figures demonstrate that even though UCFV was an early adopter of energy management, there is still great opportunity for improvement. The potential dollar and energy consumption savings that could be realized through the projects listed in the audit also demonstrate that, although great efforts have been made to promote energy

Category	Estimated Total Electrical Savings (kWh)	Estimated Total Demand Savings (kW)	Estimated Total Gas Savings (ekWh)	Estimated Total Energy Savings (ekWh)	Estimated Total Project Costs	Estimated Cost Savings
Lighting	561 669	85	0	561 669	$159,029	$26,242
Controls	392 029	20	342 791	734 820	$153,123	$17,230
Mechanical	154 582	23	575 798	730 380	$107,938	$15,520
Metering	0	0	0	0	$81,250	$19,500
Education	52 299	0	0	52 299	$2,500	$1,569
Total	1 160 579	128	918 589	2 079 168	$503,840	$80,061

Projected Success

Although UCFV's total greenhouse gas emissions have increased since it joined NRCan's Energy Innovators Initiative, it is expected that if the recommendations of the audit are implemented, UCFV's emissions will begin to decline in 1999.

- It is estimated that UCFV's CO_2 emissions from natural gas will decrease by 55 tonnes from the 1998 level to 1600 tonnes in 1999.
- By 2001, it is expected that there will be a 9.9 percent reduction in UCFV's CO_2 emissions from natural gas from 1998 levels. These savings translate into a reduction in CO_2 emissions of 165 tonnes by 2001.

Greenhouse gas emissions from UCFV's electricity consumption are expected to decrease even more.

- By 2001, there will be a 16.8 percent reduction in CO_2 emissions from 185 tonnes in 1998 to 154 tonnes in 2001.

CO_2 intensities will decrease even more significantly than they did from 1996 to 1998.

- CO_2 intensity based on the number of students is projected to fall from 0.39 tonnes/FTE in 1998 to 0.33 tonnes/FTE in 2001, which represents a 15.4 percent decrease in CO_2 emissions.
- The CO_2 intensity based on square metres is expected to be reduced by 9.7 percent from 0.041 tonnes/m^2 in 1998 to 0.037 tonnes/m^2 in 2001.

This means that UCFV will experience a 10.6 percent reduction in overall CO_2 emissions from both gas and electricity between 1998 and 2001.

efficiency at UCFV, there are still some areas that can be improved, either because of new, more energy-efficient technologies or because they were overlooked for a variety of reasons. Overcoming obstacles and reviewing lessons learned produce additional energy efficiency opportunities. Being energy efficient is an ongoing process, as UCFV has learned since joining the Energy Innovators Initiative.

CONCLUSION

Even with all these obstacles, setbacks and lessons learned, UCFV has had some major successes. All past initiatives, in conjunction with recommended future projects, have added up to make UCFV one of the most energy-efficient colleges in Canada. In achieving this reputation, UCFV is providing its students with an improved working environment, while protecting the external environment and saving money in the process.

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